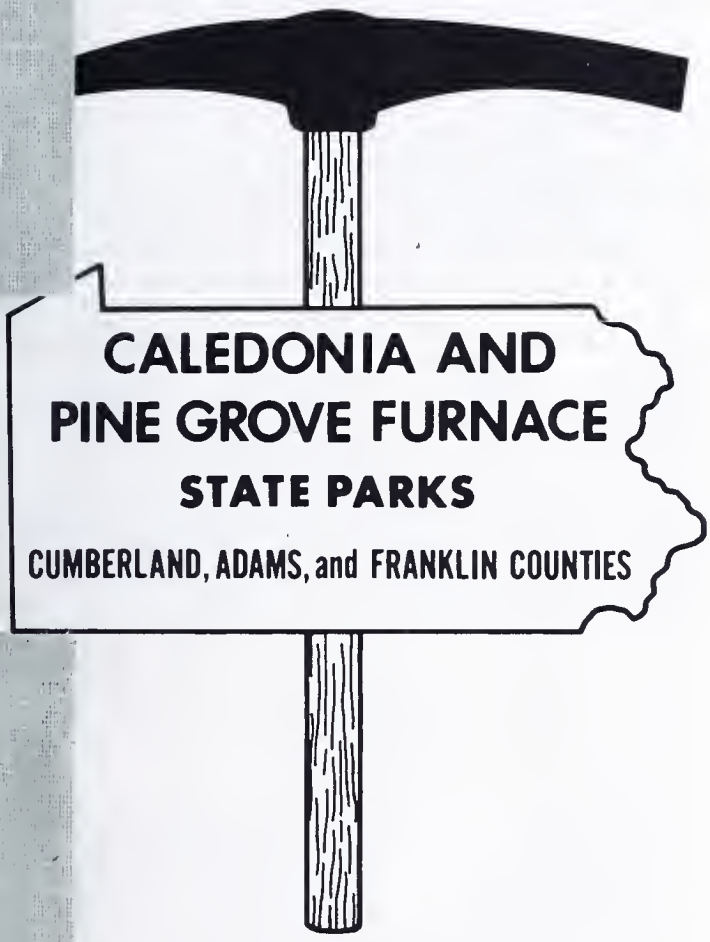
PENNSYLVANIA
TRAIL OF GEOLOGY



CALEDONIA AND PINE GROVE FURNACE STATE PARKS

CUMBERLAND, ADAMS, and FRANKLIN COUNTIES

Geologic Features and Iron Ore Industry

GEOLOGIC FEATURES OF CALEDONIA AND PINE GROVE FURNACE STATE PARKS

Caledonia and Pine Grove Furnace State Parks are located in the northernmost section of the mountainous Blue Ridge province, locally known as South Mountain.

Caledonia State Park, in Adams and Franklin Counties, is located in the valley where Carbaugh and Rocky Mountain Creeks join Conococheague Creek, which flows westward to the Potomac River (Figure 1). Chinquapin and Graefenburg Hills, both 1,522 feet in elevation, overlook the park area.

For millions of years, the creeks have drained these highlands by following paths in fractured and structurally weak rocks. They have cut through and eroded a rock thickness of at least 600 feet. The dynamic processes of weathering and erosion of the highlands, downstream transport of sediment, and subsequent deposition have occurred throughout the geologic past as they do today.

Pine Grove Furnace State Park, in Cumberland County, 12.2 miles northeast of Caledonia, is in the same topographic setting. The park is located along Mountain Creek, which joins the Yellow Breeches Creek and flows east to the Susquehanna River. Little Rocky Ridge (elevation 1,462 feet) and Piney Mountain (elevation 1,515 feet) overlook the park from opposite sides of Mountain Creek valley. This park owes its name to the discovery of iron ore deposits nearby and the rise of a busy iron industry which operated between the years 1764 and 1895.

Figure 1. Carbaugh and Rocky Mountain Creeks (right) join Conococheague Creek (center), which flows westward.

The Rocks

The rocks that form the highest ridges and hilltops in these parks are hard, dense sandstones and quartzites (Weverton Formation and Harpers Formation, Montalto Member). The Weverton Formation is a series of gray-green and purplish sandstones. The Montalto Member is white, light-gray, and blue-gray sandstone and quartzite (a metamorphosed sandstone). Both rock units are highly resistant to weathering and form the highest ridge tops.

The carbonate rock present in some of the low hillsides and valleys of South Mountain is called the Tomstown Dolomite. This rock unit is primarily gray dolomite containing interbeds of white limestone (Figure 2). It has a very low resistance to weathering and thus usually results in valleys. Iron ore found at the base of this unit was actively mined in the nineteenth century.

Figure 2. Tomstown Dolomite quarry.

Metarhyolite, a rock of volcanic origin, forms moderate to steep slopes and ridges in South Mountain. It can be observed in both park areas as green, red, and gray, fine-grained rock that may have isolated quartz and feldspar crystals (Figure 3).

The Harpers Formation and the Antietam Quartzite can be found at Orebank Hill near Caledonia State Park. The Harpers Formation is greenish-gray sandstone and the Antietam Quartzite is white to gray sandstone and quartzite.

All of these rocks were complexly folded and faulted by mountain-building processes that occurred about 330 million years ago.

Figure 3. Metarhyolite.

Geologic History

About 600 million years ago, in late Precambrian time, South Mountain was the site of considerable volcanic activity. Over a period of several million years, volcanoes erupted intermittently through fissures and vents in the basement rock (Figure 4A). Initially the flows were composed of basalt (a dark-colored volcanic rock), but this composition changed to rhyolite (a lighter colored volcanic rock) in the later stages of activity. As widespread volcanism waned, the environment of the South Mountain area began to change. The land subsided, and the terrestrial volcanic environment became a shallow sea environment.

During Early Cambrian time, clastic sediments were deposited on top of the volcanics. These sediments were transported to the sea floor by streams and rivers from landmasses to the southeast and north of the South Mountain area (Figure 4B). Sands, clays, rhyolite, and quartzite sediments were deposited to form the Weverton Formation, Antietam Quartzite, and Harpers Formation (including the Montalto Member).

By Middle Cambrian and Early Ordovician time (530 to 470 million years ago), the landmasses to the southeast and north had eroded down to lower elevations and stabilized. Sediments in the shallow sea became finer, and animal shells began to accumulate to form beds of limestone (Figure 4C). Through a natural process called diagenesis, much of this limestone was altered to dolomite. We call this present-day rock unit the

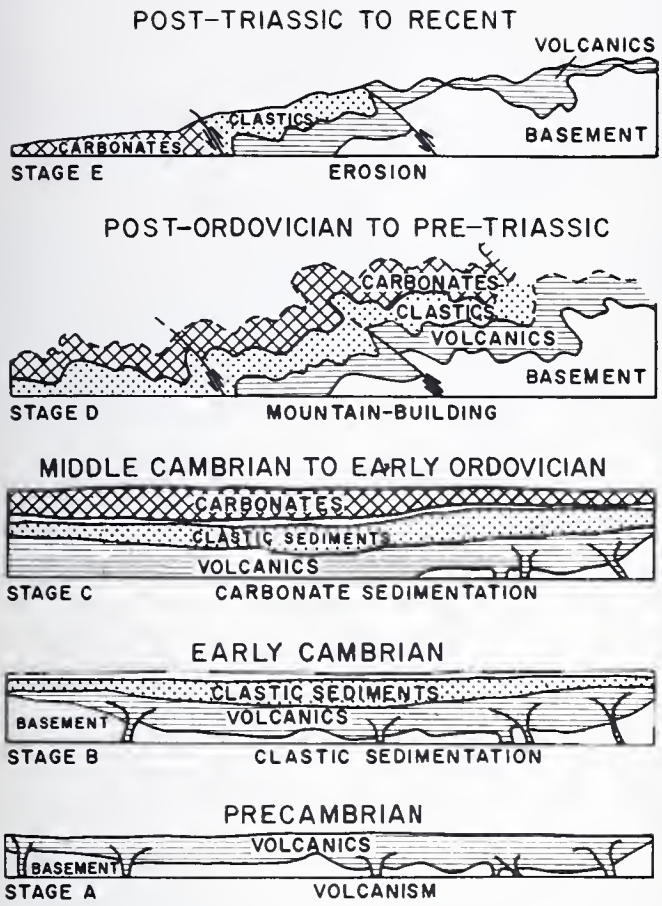
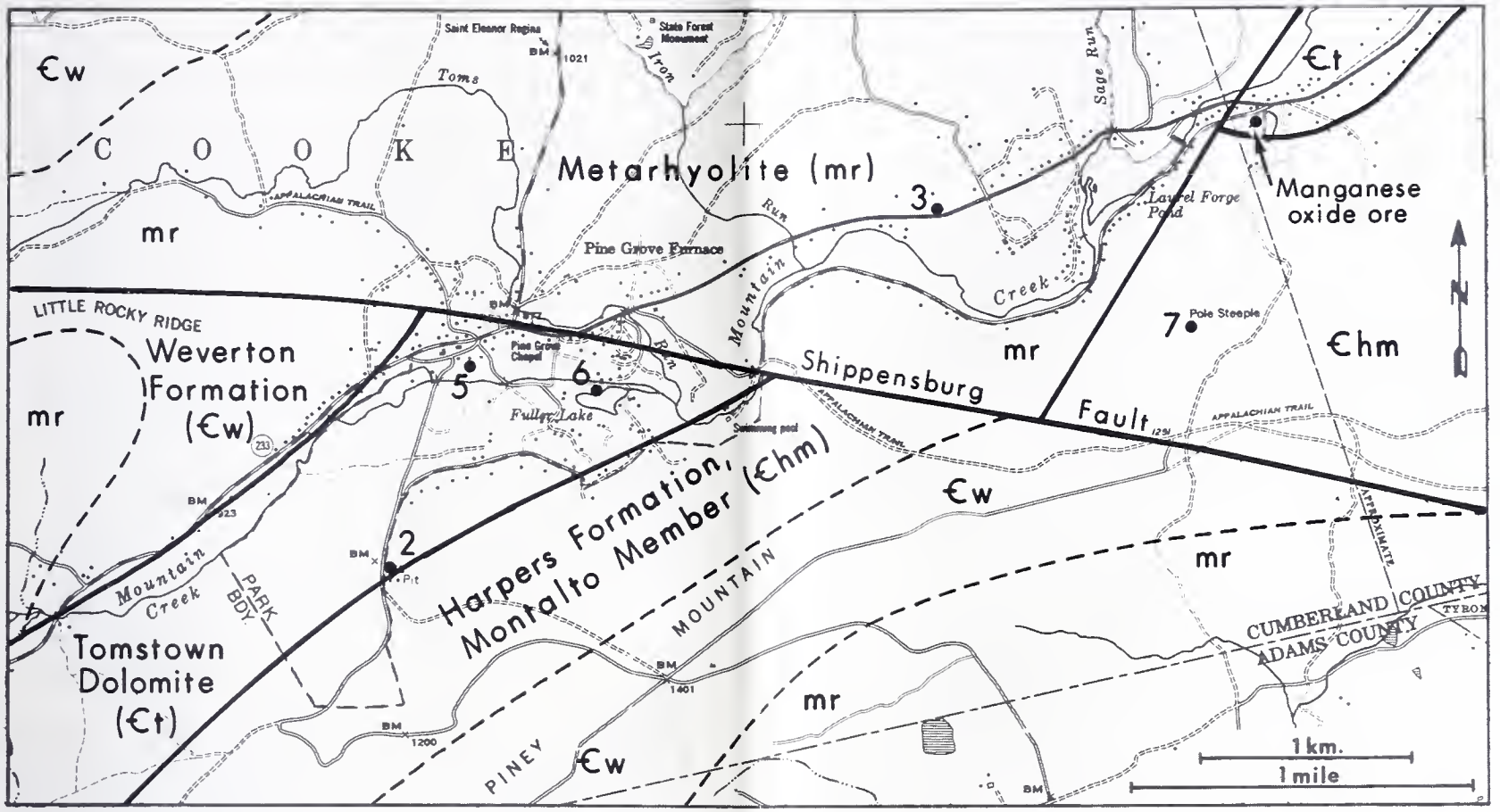


Figure 4. **Geologic history of South Mountain. Example: Caledonia Park area (drawing modified from Pennsylvania Geological Survey Atlas 129a by J. L. Fauth, p. 84).**

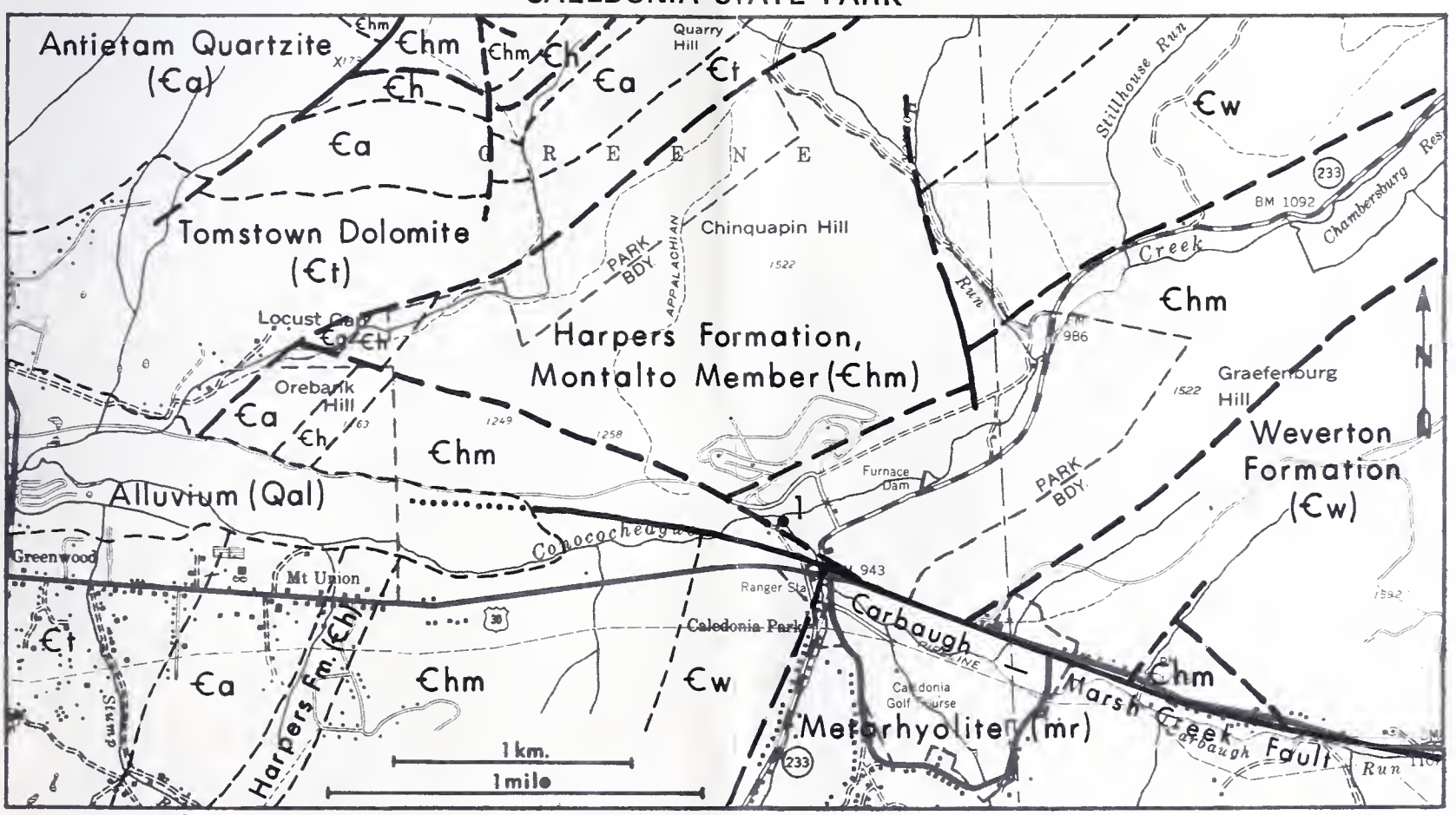
Tomstown Dolomite. Later, more limestone and calcareous shale, thousands of feet thick, were deposited on top of the Tomstown Dolomite. However, only a few remnants of these rock units can be seen today because they have been worn away by erosion.

About 330 million years ago, deformation and mountain building began to occur in this area. The sediments deposited over a period of 240 million years in the ancient sea (now sedimentary rocks) were folded, faulted, and lifted high above the water by a series of powerful crustal movements (Figure 4D). During this regional deformation, the conditions of high temperature and pressure changed the internal character of the sedimentary rocks. Most of the sandstones and shales were metamorphosed to quartzites and phyllites. The early volcanic rocks became metarhyolites and metabasalts. This mountain-building stage occurred as several pulses of activity. By Triassic time, 100 million years later, tectonic activity had finally ceased.

PINE GROVE FURNACE STATE PARK



CALEDONIA STATE PARK



Note: All park trails and roads are not included on maps. Contact park superintendents for further information.

Geology from Pa. Geol. Survey Map 1, 1980 edition.

Geology from Pa. Geol. Survey Atlas 129a, by J. L. Fauth.

For the past 230 million years, the South Mountain area has remained above sea level and has gradually eroded to its present elevation and topography (Figure 4E). During the recent glacial epochs, although South Mountain was not covered by ice, erosion was accelerated by increased precipitation, colder temperatures, and frost action. With the return of milder climatic conditions, erosion rates have slowed.

Iron Ore

The "brown ores" of South Mountain are hydrous iron oxides called goethite and limonite. The ore occurs in the contact zones between limestone/dolomite and quartzite rocks. The largest and highest grade deposits were smelted at the Pine Grove and Caledonia furnaces in the nineteenth century.

Goethite primarily occurs in a siliceous wash and residual clay. The ore was formed in a highly fractured zone at the base of the limestone and dolomite beds. Groundwater, over a long period of time, percolated through the beds of limestone, taking iron into solution as it traveled. When these iron-rich waters approached the fractured zone overlying the quartzite, iron oxide was deposited in the form of nodules and irregular masses. These deposits exist in varying amounts and purities in Mountain Creek valley and areas along the western flank of South Mountain.

Caledonia Furnace was in operation between the years of 1837 and 1863. The furnace stack was built into the side of Graefenburg Hill for added ease in loading the ore, lime, and charcoal necessary to produce pig iron. Slag, a fusion of limestone and ore impurities, can still be found in the vicinity of the parking lot adjacent to the old furnace stack. Ore for the furnace was mined from deposits at the fork of Hosack Run and at locations along a string of hills to the northwest; Quarry Hill, Quarry Gap Hill, Wigwam Hill, Wolf Hill, and Rocky Knob. All of the ore deposits, except for Hosack Run, occur where the Tomstown Dolomite comes in contact with the Antietam Quartzite. The ore at Hosack Run is found along the Montalto Member.

Operations at Caledonia Furnace were abruptly terminated when Confederate General Early moved through the Cashtown Gap in June of 1863 and burned the ironworks to the ground,

leaving only the blacksmith's shop and furnace stack standing.

A few miles to the northeast of Caledonia are the Wildcat Ore Banks. These banks, at the headwaters of Mountain Creek, were worked in conjunction with the ore banks at Pine Grove to furnish ore for the Pine Grove Furnace (Figure 5). Most of these deposits occur along the contact between the Tomstown Dolomite and the Antietam Quartzite. To the east of Pine Grove Furnace, manganese oxide replaced black iron oxide in some of the ore masses. Although the manganese oxide is a good grade, it is not mined because of its overall low concentration in the ore. These manganese oxide deposits are located along the west side of the water-filled ore pit adjacent to Old Forge Road (location on map). Fuller Lake, central to the park, is the site of a primary ore pit that flooded in 1893 (Figure 6). This event coincided with the final shutdown of the works, which had been in operation for 132 years.

Figure 5. Pine Grove Furnace stack.

Faults

Faults are predominant geologic features in both Caledonia and Pine Grove Furnace State Parks. They strongly influence the topography and geologic relations between the rock units. A fault is defined as a fracture in rock along which there has been movement up or down, left or right, or a combination of both. Two major faults that intersect the park areas are the Shippensburg and Carbaugh-Marsh Creek faults.

Figure 6. Fuller Lake.

The Carbaugh-Marsh Creek fault is located in the valley occupied by Carbaugh, Marsh, and Conococheague Creeks (see Caledonia map). The fault can be traced along Route 30 from Cashtown to Chinquapin Hill before it disappears into the thick surficial sediments of the Conococheague Creek valley. The Shippensburg fault does not follow a continuous valley but forms a trace 23 miles across South Mountain from the Gardners area into the Cumberland Valley. The Shippensburg fault crosses Mountain Creek valley at Pine Grove Furnace (see park map).

These faults were thought to be active during the latter stages of mountain building, 250 million years ago. Although it is difficult to decipher relative movement, similar geologic structures can be matched across the fault blocks. By matching similar vertical beds of quartzite and structures in metarhyolite, it was found that the northern part of the Shippensburg fault had been uplifted 2,900 to 4,200 feet and shifted to the west (relative to the southern part). By using similar evidence, the northern fault block of the Carbaugh-Marsh Creek fault was found to be shifted to the east, abruptly terminating all structural and topographic features.

Both faults have relatively straight traces across South Mountain, which indicates a near vertical angle or dip to the fault surfaces. Although the geological evidence described above clearly indicates where the faults occur, the actual fault zones are not visible in the park areas.

Figure 7. Pole Steeple.

Pole Steeple

The most visible geologic feature of these parks can be viewed from Laurel Forge Pond. It is an outstanding outcrop of highly resistant quartzite called Pole Steeple, 1,200 feet downslope from the ridge crest of Piney Mountain (Figure 7). Pole Steeple is a cliff of light- to medium-gray, tightly cemented quartzite of the Montalto Member. The quartzite that forms this promontory is more resistant to a primary weathering agent, frost action, than the surrounding sandstones and quartzites. Pole Steeple stands at an elevation of 1,300 feet, overlooking Laurel Forge Pond 526 feet below. This beautiful site provides an exceptional overlook of Mountain Creek valley and surrounding highlands.

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